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Agricultural Memorandum No. 330

Watercress Trials in Hampshire, 1969-70

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Introduction

The watercress industry has recently come to recognise the need for investigating certain factors of winter watercress culture, including temperature variation, nutrient, cover etc. A prominent grower, Mr M J Isaac, made available an area for experiments at Fobdown Farm, Alresford, Hampshire, and in conjunction with him, NAAS Winchester have constructed seventeen 60 x 7½ foot concrete beds, most fed by well water (at an initial temperature close to 51°F throughout the year) but three by stale water (i.e. water which already has flowed down outdoor cress beds). The beds were gravelled and rolled; the depth of water varied a little with the flow rate (which could be varied within a wide range) and crop growth, but it was usually only a few inches. Beds were orientated east/west lengthwise, and bed 1 was the furthest north; photographs of the site are shown in Hurst (1970), or Grower (1970). Thirteen of the beds were available to the NAAS for organised experiments, and collaboration of the Meteorological Office was invited. The project is designed to extend over several winters (October to April) and in fact in 1969, experiments started in November.

Meteorological Instruments 1969-70

The main interest in the year lay in the fall of temperature within the water at different flow rates, and in monitoring air temperatures in a bed sheltered by a (moveable) P.V.C. cover.

Bed No.	Flow Rate	Instruments	Remarks
2	Variable	In water at top and bottom of bed	Stale water regime, with long period without crop due to pump failure, and frost.
4	320 gal/hr/yd	" " " "	Well-water, intended as standard bed, but flow rate varied considerably especially towards end of experiment.
5	480 " " "	" " " "	Well-water.
8	320 " " "	" " " "	" "
11	80 " " "	" " " "	" "
12	320 " " "	" " " "	
		Small screen, wet and dry readings taken	Uncovered to 6-1-70 Covered by tunnel from 7-1-70. Steady flow rate early, rather variable late in experiments.

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In addition, continuous records of temperature were taken in a standard meteorological screen nearby, and a continuous record of wind flow at 6 feet was also maintained. 0900 GMT daily readings were made of the conventional dry and wet thermometers and also of maximum and minimum temperatures, and 24 hour rainfall totals were recorded.

Little trouble arose with the instruments, and almost unbroken records were maintained. Several checks were made on the accuracy of recording thermographs during the experiments, and the tables given with this paper are based on the best possible values. Readings from these traces could only be fairly taken to the nearest 0.5°F; most of the subsequent analysis has been done using 10-day means, and it is thought that a difference of the order of 0.2°F between two thermograph readings is not significant. However mean differences of this order over the season would almost certainly be meaningful.

General Remarks on Cropping

It is not thought feasible to try to relate temperature with cropping this year, but this might be possible in future. In very general terms, conclusions drawn by the Horticultural Adviser were:

(a) The low cropping level in the stale water beds was probably because of low temperatures rather than lack of nutrient. In any case experiments were largely vitiated by pump failure in December, and consequent freezing of water in the beds.

(b) With really low flow rates, a late but satisfactory crop was obtained. Lateness was thought to be because of low temperatures down the beds.

(c) The medium and high flow rates (320 and 480) did not differ greatly in cropping; there was slight advantage in the high rate to the extent of 3% in crop weight and 5% in bunch numbers, but this had to be off-set against far higher water consumption (of the order of 250,000 gallons monthly for each bed).

(d) Covered crops were much lower in yield than uncovered (the low light level because of an almost continuous layer of water droplets on the inside surface of the polythene may be significant) though carbon dioxide gave marked increase (about 20%) in yield. However, much earlier cropping was possible, and in mid-February for example approximately 80 lbs cress was taken from each of two beds, with further harvest in late March of another 70 lbs from each bed. Mid-March harvesting of uncovered beds gave yields of about 335 lbs (but with a much smaller proportion of high grade cress). Cropping on 1st April gave yields of over 400 lbs, again with a very low proportion of high grade cress. Economics of watercress growing are of course no concern of this memorandum, but the balance between small quantities of early high grade cress compared with bigger yields of later lower grade quality cress is relevant.

(e) Some readings were taken of total crop growth at the top, middle and bottom of some beds in April. Weights were highest at the top of the beds and least at the bottom (except in one unlevel bed with a shallow middle); these differences are not related directly to cropping values, as other factors enter.

/Analysis

Analysis

It was found convenient to analyse the data as approximately 10-day means from 1st November onwards (i.e. 1-10, 11-20 and 21-end of each month) and in Appexdix 1 are listed mean values for maximum and minumum temperatures in the beds 2, 4, 5, 8, 11 and 12 together with air temperatures and mean sunshine (for Martyr Worthy about five miles away) for the same period. Appendix 2 compares air temperatures in the covered bed with those in the open, and also indicates relative humidity under cover and in the open. Before discussing these results, it is interesting to note the correlation between the flow rate, the fall of temperature down the (open) bed and the air temperature, given in Table I.

TABLE I

Correlations between temperature change down the bed and air temperatures, with different flow rates

Correlation between	Flow Rate (gal/hr/yd)		
	80	320	480
Day: Maximum air temperature and fall of temperature down the bed.	-0.70	-0.63	-0.46
Night: Minimum air temperature and fall of temperature down the bed.	-0.75	-0.63	-0.40
Average 24-hour mean temperature and fall of temperature down the bed.	-0.94	-0.64	-0.36

Correlations are based on 15 sets of 10-day averages, and significance is on the 0.1%, 1% and 10% levels with correlations of approximately $\pm$ 0.75, 0.62 and 0.40 respectively. Clearly the relationship between air temperature and flow rate is very high with low water flow (though 0.94 is rather suspect) and decreases markedly with more through-flow of water. The fall of temperature down the bed in winter, very approximately was 3°F for a difference of 10°F between well-water (at about 50°F) and air temperature for the 80 gals/hr/yd flow. Differences were approximately proportional for higher rates of flow, and at greater temperature differences; thus the 480 flow with 15° temperature difference would give a temperature fall of about 0.7°F. This relationship was approximately true for both minimum (water and air) and maximum temperatures. The data refer mostly to beds well-covered with cress, but during the period in late February for example bed 4 was only partly covered by cress. Bed 12 was not considered for Table I as the cover had been put over in January 1970. It will be seen that the correlations are higher with day temperatures with fast flow, and higher with night temperatures with slow flow; however the correlations (apart from the value -0.94) are not very different from each other within each flow rate category, and this result may well be fortuitous.

/In

In the detailed summary in Appendix I, it will be seen that in the cold of winter (in fact until late February) a fall of temperature occurs down open beds from the starting temperature of about 50°F, and this fall averaged as much as 8.7°F by night and 4.5°F by day from 1-10 January. This was naturally with the lowest flow rate (80 gal/hr/yd) and falls were just about a sixth of this with the 480 flow rate: 1.4°F and 0.7°F respectively.

In late winter and early spring, some variations in inlet temperatures werenot very easy to explain. The period 11-20 March for example showed lower inlet temperatures than in the previous or following periods, though the weather was not cold, and indeed the 10 days were distinctly warmer than the previous 10; possibly it may have been because the period 11-20 was dull whereas before and after the weather was sunny. In this same period however temperatures at mid-day were higher at the bottom of the bed than the top - despite the average maximum temperature being below well temperature; only with the slow flow rate was this not the case.

Temperatures in the water in the covered bed are also given in the Appendix, and analyses of air temperatures in bed 12 are given in Appendix II. It was found that the difference between air temperatures in the open and under cover (above water) were not very great in dull weather and were much less in mid-winter than later. In January, for example, air temperatures were about 2.5°F higher under cover, and in March about 10°F by day; differences at night were 2-3°F January and about 6°F in March, but figures varied widely. Biggest differences arose in sunny weather in early March, with an average 24 hour difference of around 12°F. Maximum temperatures were found to occur soon after mid-day, earlier than in the open; this would be in association with maximum insolation. With transpiration, relative humidity is high under cover and the 10-daily average never fell below 97% during the experiment and was always 100% by night. Relative humidity probably never fell below 90% at all. Measurements of water temperature under cover (Appendix I) in January and early February did not show much difference down the bed from the open faster rates of flow, but from about mid-February the day maximum temperature rose down the bed every day without a great deal of difference between sunny and dull weather. In fact, this rise down the bed followed immediately cropping and reduction of flow rate, with average maximum temperatures well below 50°F (though under cover air temperatures exceeded 50°F at mid-day on the average). This must be an effect of radiative heating of the water, an approximate value was calculated:

On the rate of flow 160 gals/hr/yd, the hourly through-flow would be 400 gal for the bed (64 ft^2) and with an (estimated) depth of 4 in, the volume of the bed will be 60 x $7\frac{1}{2}$ x $\frac{1}{3}$ = 150 ft^3, so the time of through-flow would be 2.3 hours.

Taking period 11-20 February, the average rise in temperature down the bed was 2.3°F = 1.3°C, and assuming the 4 in bed depth, the heat to warm 1 cm^2 of surface water 10 cm deep by 1.3°C would be 10 x 1.3 = 13 cal.

Now the energy available at around mid-day (taken from Kew) for the period was 27.5 mw/cm^2 (= 23.7 $cal/cm^2/hr$) so that the heat for 2.3 hours would be 54 cal. Bearing in mind factors such as the opacity of the PVC cover, this is thought to be quite good agreement. Such calculations would not apply for water in the open, because of the loss of heat to cooler air.

/Plans

Plans for 1970-71

Two Kent recorders will be introduced, but two mercury-in-steel thermographs will still be employed. This is the second of several years programmes, and it is thought that a high priority should be to examine one bed more thoroughly than last year, and supplement this with information of particular interest to the NAAS team. Each recorder can take six simultaneous temperature records, and present plans are to take continuous recordings of temperature as follows:

Recording	Position	Flow	Remarks
Kent No. 1	6	200, Well	Top, $\frac{1}{3}$, $\frac{2}{3}$, and bottom of bed; each side at $\frac{1}{3}$ down.
Kent No. 2	3	200, Stale	Top and bottom.
	4	400, Well	" " "
	5	600, Well	" " "

No bed with number less than 8 will be covered, so there will be no possibility of results being compromised by variable proximity to cover.

Screens with maximum, minimum, dry and wet thermometer readings, and mercury-in-steel thermograph will be maintained in the open as before, and run of wind will again be recorded. Additionally, sunshine will be measured on the site. Ideally, radiation should be measured, but this is out of the range of the experiments for this season; it is intended however to provide a light recorder (photographic light meter, probably) and attempt to obtain representative readings of illumination in the open and under the various covers. Another factor which it is wished to measure is the temperature of the well-water; this is supposed to be at a steady level of around 50 or 51°F, but there is a suspicion that there may be variation of a degree or two and this should be examined. It would be best to measure this temperature continuously (at least for a time) but a recorder is not available for the purpose, so the intention is to use an Inspector's mercury thermometer daily for the first month at least.

Other aspects of meteorological interest are:

Depth of water should be measured, and NAAS are arranging for the introduction of three gauges for each bed (top, centre and bottom) for their own interest as well as that of Met O 8. The effect of hail or snow, if exceptionally heavy, on water temperature may be real, and Mr Isaac has promised to ensure that as far as possible unusually heavy precipitation of this sort will be noted.

Differences of taking crops at different parts of the bed are considerable, but it is expected that with bed 6 at least, comparative yields will be available, either as done this year, or in a different form. It is hoped at the end of the forthcoming experiments to be able to programme the computer to analyse results, and build up the profile of temperature fall (or rise possibly in March or April) down the bed - which should be exponential. This would enable the profile of temperatures on other beds to be stated, provided the terminal temperatures are known.

/Finally

Finally, a mercury-in-steel thermograph will be installed in one of the covered beds to monitor air temperature and humidity, probably in the bed in which forced ventilation will be tried, in an attempt to reduce or eliminate transpiration condensation on the cover and to improve the light level.

Acknowledgements

The appreciation of the Meteorological Office to all concerned in the arrangements is very real, and in particular, Messrs M.J. Isaac, Fobdown; R. C. Round, NAAS (Winchester, now Bristol), C. P. Stevens and A Renouf, NAAS, (Winchester); the two latter were responsible for almost all the observations, chart changing etc.

References:

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Anon — Watercress growers see first steps towards blueprint. Grower 21-3-70, p. 729.

Any comments or suggestions on this memorandum should be sent to the Authors.

Meteorological Office
Bracknell
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June 1970

CHANGES IN WATER TEMPERATURE IN BEDS (°F)

PERIOD	AIR MAX.	AIR MIN.	AIR MEAN	AIR SUN		BED 2 MAX.	BED 2 MIN.	BED 2 MEAN	BED 2 FLOW	BED 4 MAX.	BED 4 MIN.	BED 4 MEAN	BED 4 FLOW	BED 5 MAX.	BED 5 MIN.	BED 5 MEAN	BED 5 FLOW
1.11-10.11.69	55.5	38.6	47.0	3.48	TOP	51.2	50.3	50.7	160 ↓	50.9	50.0	50.5	160 ↓	50.7	50.0	50.3	480
					BOTTOM	51.6	48.1	49.9	320	52.2	48.2	50.2	320	50.9	49.0	49.9	↓
					Δ	-0.4	2.2	0.8	(6)	-1.3	1.8	0.3	(6)	-0.2	1.0	0.4	
									↓				↓				
11.11-20.11	49.8	32.9	41.4	2.20		50.3	49.5	49.9		49.9	49.3	49.6		49.9	49.7	49.8	
						50.2	47.8	49.0		50.3	48.2	49.3		49.8	48.4	49.1	
						0.1	1.7	0.9		-0.4	1.1	0.3		0.1	1.3	0.7	
21.11-30.11	43.2	31.8	37.5	3.58		50.5	49.7	50.1		50.1	49.4	49.7		50.1	49.7	49.9	
						48.4	47.5	47.9		48.8	46.6	47.7		48.8	47.5	48.1	
						2.1	2.2	2.2		1.3	2.8	2.0		1.3	2.2	1.8	
1.12-10.12	45.2	29.7	37.5	1.96						49.7	48.9	49.3		49.7	49.3	49.5	
										49.2	46.6	47.9		49.4	48.0	48.7	
										0.5	2.3	1.4		0.3	1.3	0.8	
11.12-20.12	42.7	32.8	37.7	1.38						49.7	48.7	49.2		49.9	49.3	49.6	
										49.0	47.6	48.3		49.1	48.4	48.7	
										0.7	1.1	0.9		0.8	0.9	0.9	
21.12-31.12	43.2	35.4	39.3	0.22						49.8	49.3	49.5		49.8	49.6	49.7	
										49.1	48.1	48.6		49.3	48.8	49.1	
										0.7	1.2	0.9		0.5	0.8	0.6	
1. 1-10.1.70	40.6	24.1	32.3	1.84						49.8	49.1	49.5		49.9	49.4	49.7	
										48.8	46.4	47.6		49.2	48.0	48.6	
										1.0	2.7	1.9		0.7	1.4	1.1	
11. 1-20.1	47.6	41.0	44.3	0.05						50.1	49.3	49.7		50.0	49.5	49.7	
										49.5	48.3	48.9		49.8	48.9	49.3	
										0.6	1.0	0.8		0.2	0.6	0.4	
21. 1-31.1	46.3	37.4	41.9	0.89						50.1	49.5	49.8		50.0	49.6	49.8	
										50.0	48.9	49.5		49.9	49.3	49.6	
										0.1	0.6	0.3		0.1	0.3	0.2	
1. 2-10.2	46.7	33.8	40.3	4.41		49.3	44.4	46.9	200	50.5	49.3	49.9		50.2	49.8	50.0	
						47.8	38.5	43.1	↓	50.0	45.6	47.8	80	50.0	49.4	49.7	
						1.5	5.9	3.8		0.5	3.7	2.1	(6)	0.2	0.4	0.3	
													↓				
11.2-20.2	42.1	27.4	34.7	5.07		48.5	40.4	44.5		50.2	48.6	49.4	200	50.1	49.2	49.7	
						47.7	36.4	42.1		49.7	41.4	45.5	↓	50.1	48.5	49.3	520
						0.8	4.0	2.4		0.5	7.2	3.9		0.0	0.7	0.4	↓
21.2-28.2	45.5	35.7	40.6	2.07		49.4	45.1	47.3		50.7	49.8	50.3		50.2	49.8	50.0	
						49.7	42.7	46.2		51.1	46.8	48.9		50.5	49.4	49.9	
						-0.3	2.4	1.1		-0.4	3.0	1.4		-0.3	0.4	0.1	
1.3-10.3	41.0	25.4	33.2	4.22		49.1	43.9	46.5	250	50.9	49.9	50.4	250	50.5	50.1	50.3	
						49.6	39.6	44.6	↓	51.0	45.2	48.1	↓	50.8	49.4	50.1	
						-0.5	4.3	1.9		-0.1	4.7	2.3		-0.3	0.7	0.2	
11.3-20.3	48.5	35.4	41.9	2.30		49.9	46.1	48.0		50.4	49.5	49.9		50.3	49.9	50.1	
						51.0	44.2	47.6		51.3	47.6	49.5		50.9	50.0	50.5	
						-1.1	1.9	0.4		-0.9	1.9	0.4		-0.6	-0.1	-0.4	
21.3-31.3	(48.5)	(35.9)	(42.2)	3.45		50.7	46.3	48.5		51.0	49.8	50.4		50.5	50.1	50.3	
	(some vales estimated)					52.4	45.2	48.8	500	51.7	49.1	50.4	500	50.8	50.0	50.4	
						-1.7	1.1	-0.3	(26)	-0.7	0.7	0.0	(26)	-0.3	0.1	-0.1	
									↓				↓				

PERIOD	BED 8 MAX.	BED 8 MIN.	BED 8 MEAN	BED 8 FLOW	BED 11 MAX.	BED 11 MIN.	BED 11 MEAN	BED 11 FLOW	BED 12* MAX.	BED 12* MIN.	BED 12* MEAN	BED 12* FLOW	MEAN Δ FLOW	MEAN Δ MAX.	MEAN Δ MIN.	MEAN Δ MEAN
1.11-10.11.69	50.4	49.8	50.1	320	50.6	49.8	50.2	80	50.7	50.1	50.4	160	80	-0.7	3.3	1.3
	51.5	48.9	50.2	↓	51.3	46.5	48.9	↓	51.3	48.2	49.7	320	320	-0.9	1.7	0.4
	-1.1	0.9	-0.1		-0.7	3.3	1.3		-0.6	1.9	0.7	(6)	480	-0.2	1.0	0.4
												↓				
11.11-20.11	49.8	49.3	49.5		49.8	49.0	49.4		50.1	49.6	49.9		80	1.5	5.1	3.3
	50.1	48.3	49.2		48.3	43.9	46.1		49.3	47.5	48.4		320	0.1	1.5	0.8
	-0.3	1.0	0.3		1.5	5.1	3.3		0.8	2.1	1.5		480	0.1	1.3	0.7
21.11-30.11	50.1	49.4	49.7		49.5	48.8	49.1		50.1	49.5	49.8		80	4.1	6.4	5.2
	48.7	47.1	47.9		45.4	42.4	43.9		48.2	46.5	47.3		320	1.7	2.6	2.1
	1.4	2.3	1.8		4.1	6.4	5.2		1.9	3.0	2.5		480	1.3	2.2	1.8
1.12-10.12	49.6	49.2	49.4		49.6	48.8	49.2		50.1	49.5	49.8		80	3.2	7.2	5.2
	49.4	47.7	48.5		46.4	41.6	44.0		48.6	46.7	47.7		320	0.7	2.2	1.5
	0.2	1.5	0.9		3.2	7.2	5.2		1.5	2.8	2.1		480	0.3	1.3	0.8
11.12-20.12	49.8	49.2	49.5		49.2	48.8	49.0		49.9	49.4	49.7		80	3.3	5.4	4.3
	48.9	47.9	48.4		45.9	43.4	44.7		48.3	47.3	47.8		320	1.1	1.5	1.3
	0.9	1.3	1.1		3.3	5.4	4.3		1.6	2.1	1.9		480	0.8	0.9	0.9
21.12-31.12	49.6	49.2	49.4		49.2	48.6	48.9		49.9	49.3	49.6		80	3.2	4.0	3.6
	49.0	48.3	48.7		46.0	44.6	45.3		48.5	47.6	48.1		320	0.9	1.3	1.0
	0.6	0.9	0.7		3.2	4.0	3.6		1.4	1.7	1.5		480	0.5	0.8	0.6
1. 1-10.1.70	49.6	49.1	49.3		49.1	48.4	48.7		50.0	49.3	49.7		80	4.5	8.7	6.6
	49.0	47.0	48.0		44.6	39.7	42.1		47.9	46.1	47.0		320	1.2	2.7	2.0
	0.6	2.1	1.3		4.5	8.7	6.6		2.1	3.2	2.7		480	0.7	1.4	1.1
11. 1-20.1	49.7	49.2	49.5		49.7	48.8	49.3		50.2	49.3	49.7		80	1.9	4.0	3.0
	49.7	48.5	49.1		47.8	44.8	46.3		49.9	48.9	49.4		320	0.6	0.9	0.6
	0.0	0.7	0.4		1.9	4.0	3.0		0.3	0.4	0.3		480	0.2	0.6	0.4
21. 1-31.1	49.8	49.2	49.5		49.7	49.0	49.3		50.2	49.5	49.9		80	1.3	2.9	2.0
	50.0	48.8	49.4		48.4	46.1	47.3		50.1	48.8	49.5		320	-0.1	0.5	0.2
	-0.2	0.4	0.1		1.3	2.9	2.0		0.1	0.7	0.4		480	0.1	0.3	0.2
1. 2-10.2	50.0	49.4	49.7		50.2	49.2	49.7		50.7	50.1	50.4		80	2.6	4.4	3.5
	50.1	48.7	49.4		47.6	44.8	46.2		50.3	49.1	49.7		320	0.2	2.2	1.2
	-0.1	0.7	0.3		2.6	4.4	3.5		0.4	1.0	0.7		480	0.2	0.4	0.3
11.2-20.2	49.9	49.4	49.7		50.0	49.0	49.5		50.5	49.7	50.1		80	2.2	6.4	4.3
	49.7	47.1	48.4		47.8	42.6	45.2	120	52.8	48.0	50.4	160	320	0.2	2.3	1.3
	0.2	2.3	1.3		2.2	6.4	4.3	↓	-2.3	1.3	-0.3	↓	480	0.0	0.7	0.4
21.2-28.2	50.0	49.4	49.7		49.8	49.0	49.4		50.4	49.7	50.1		80	0.4	3.6	2.0
	50.5	49.0	49.7		49.4	45.4	47.4		52.7	48.4	50.5		320	-0.5	0.4	0.0
	-0.5	0.4	0.0		0.4	3.6	2.0		-2.3	1.3	-0.4		480	-0.3	-0.4	0.1
1.3-10.3	50.4	50.1	50.3		50.4	49.5	49.9		50.9	50.1	50.5		80	1.0	4.6	2.8
	50.6	48.6	49.6		49.4	44.9	47.1		54.0	48.1	51.1		320	-0.2	1.5	0.7
	-0.2	1.5	0.7		1.0	4.6	2.8		-3.1	2.0	-0.6		480	-0.3	0.7	0.2
11.3-20.3	50.3	49.7	50.0		50.2	49.3	49.7		50.6	49.8	50.2		80	0.4	2.7	1.5
	50.8	49.5	50.1		49.8	46.6	48.2		52.7	49.1	50.9	480	320	-0.5	0.2	-0.1
	-0.5	0.2	-0.1		0.4	2.7	1.5		-2.1	0.7	-0.7	(16)	480	-0.5	0.2	-0.1
												↓				
21.3-31.3	50.5	50.1	50.3		50.5	49.6	50.1		51.0	50.2	50.6		80	0.0	1.7	0.9
	50.9	49.9	50.4		50.5	47.9	49.2		52.6	49.7	51.1		320	-0.4	0.2	-0.1
	-0.4	0.2	-0.1		0.0	1.7	0.9		-1.6	0.5	-0.5		480	-0.4	0.2	-0.1

* BED 12 covered from 7.1.70 FLOW RATE IN GAL/hr/yd width Figures in brackets give date of change in flow rate.

APPENDIX II

TEMPERATURE AND HUMIDITY OF OUTSIDE AIR AND UNDER PVC COVER ON BED 12

Period/Time		TEMPERATURES °F 00	03	06	09	12	15	18	21	Max.	Min.	Diurnal Range	Mean Sun	RELATIVE HUMIDITY % 00	03	06	09	12	15	18	21
15.1.70-20.1.70	Air	43.7	43.9	43.9	44.2	44.8	45.6	44.9	44.8	46.8	41.9	4.9		98	97	99	97	97	97	99	97
	Cover	46.3	45.9	46.0	45.9	47.3	48.0	47.2	47.0	48.5	45.3	3.2	0.00	100	100	100	100	100	100	100	100
	Δ(C-A)	2.6	2.0	2.1	1.7	2.5	2.4	2.3	2.2	1.7	3.4										
21.1-31.1	Air	43.0	41.6	40.5	41.4	45.3	45.0	42.4	41.9	46.4	37.4	9.0		97	98	98	99	98	92	96	95
	Cover	45.0	43.7	43.5	44.6	48.8	49.0	45.1	44.7	50.4	42.4	8.0	0.89	100	100	100	100	99+	99+	100	100
	Δ(C-A)	2.0	2.1	3.0	3.2	5.3	4.0	2.7	2.8	4.0	5.0										
1.2-10.2	Air	39.1	38.8	38.7	39.9	43.5	43.7	40.7	38.9	46.7	33.8	12.9		94	93	95	90	80	79	92	90
	Cover	41.8	41.5	40.8	42.3	52.2	52.0	43.9	41.7	55.7	39.2	16.5	4.41	100	100	100	100	100	98	100	100
	Δ(C-A)	2.7	2.7	2.1	2.4	8.7	8.3	3.2	2.8	9.0	5.4										
11.2-20.2	Air	34.2	33.5	32.9	34.5	39.5	40.7	36.9	35.7	42.1	27.4	14.7		98	97	98	95	88	77	95	96
	Cover	41.3	40.7	39.9	42.1	50.6	51.0	44.3	42.9	53.3	38.9	14.4	5.07	100	100	100	100	97	98	100	100
	Δ(C-A)	7.1	7.2	7.0	7.6	11.1	10.3	7.4	7.2	11.2	11.5										
21.2-28.2	Air	38.9	39.2	39.5	40.9	44.3	45.0	42.1	39.1	45.5	35.7	9.8		95	96	96	94	84	79	85	93
	Cover	44.2	43.8	43.8	44.6	51.7	50.3	46.8	44.3	52.7	42.7	10.0	2.07	100	100	100	100	100	99-	100	100
	Δ(C-A)	5.3	4.6	4.3	3.7	7.4	5.3	4.7	5.2	7.2	7.0										
1.3-10.3	Air	30.0	29.9	27.1	34.1	38.2	38.7	35.0	32.7	41.0	25.4	15.6		98	99+	97	94	85	79	93	98
	Cover	40.7	39.7	39.1	44.5	50.2	49.9	43.8	41.5	52.9	38.7	14.2	4.22	100	100	100	99+	97	98	100	100
	Δ(C-A)	10.7	9.8	12.0	10.4	12.0	11.2	8.8	8.8	11.9	13.3										
11.3-20.3	Air	37.9	38.5	38.7	41.7	45.6	46.7	44.8	41.8	48.5	35.4	13.1		96	96	96	89	86	84	87	95
	Cover	43.9	43.3	43.1	48.6	53.1	54.3	49.7	46.3	56.9	41.9	15.0	2.30	100	100	100	97	99-	99	100	100
	Δ(C-A)	6.0	4.8	4.4	6.9	7.5	7.6	4.9	4.5	8.4	6.5										
21.3-31.3	Air	39.8	38.9	38.2	42.2	46.6	47.3	44.2	40.8	48.5*	35.9*	12.6		95	95	98	89	78	76	86	93
	Cover	44.4	43.6	43.2	50.2	58.1	57.3	50.0	45.5	61.6	42.4	19.2	3.45	100	100	100	99+	99	98	100	100
	Δ(C-A)	4.6	4.7	5.0	8.0	11.5	10.0	5.8	4.7	13.1	6.5										

*Some values estimated from thermograph

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